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I, LEANNE MYNOTT, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PP 5586 for a patent by PACIFIC SOLAR PTY LIMITED filed on 31 August 1998.

WITNESS my hand this
Eighth day of October 1999

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AUSTRALIA

Patents Act 1990

PACIFIC SOLAR PTY LIMITED

PROVISIONAL SPECIFICATION

Invention Title:

Frame for mounting a panel or the like to a roof

The invention is described in the following statement:

Field of the Invention

This invention relates to a frame for mounting a panel, particularly a solar (photovoltaic) panel or the like, to a roof, and also to a method of fixing such a frame to a roof and mounting a panel thereon.

Background of the Invention

To date, solar panels have been mounted hard against or standing-off from roofs in an array, individually fixed to the roof structure by attachment brackets. It is important that adjacent panels are mounted in a co-planar fashion, in-line and equally spaced apart, since due to the reflective nature of the solar panels, any misalignment is obvious and unacceptable for aesthetic reasons. The tolerances usual in roof structure construction are translated to the solar panels through the brackets, making it difficult to achieve the desired accuracy. Additionally, the labour costs of securing such brackets on roofs is unacceptably high.

The shortcomings associated with the abovementioned bracket mounting method have been overcome by using substantially rigid support structures onto which an array of solar panels is attached. The structure can provide the necessary alignment tolerances to meet aesthetic requirements.

However, the size of such support structures requires the use of a crane or other heavy lifting machine to elevate them from the ground to above the roof. Each structure must be purpose designed for the particular array of panels. This negates the benefit associated with the modularity of solar panels. It can also lead to difficulties in removing a solar panel for the purpose of repair or replacement.

The present invention seeks to alleviate the disadvantages of the prior art and provide a method and apparatus for accurate releasable mounting of an array of solar panels or the like onto pitched or flat roofs, without compromising the benefits of modularity and at a reasonable cost.

Summary of the Invention

In a first broad aspect of the present invention, there is provided a method of forming a framework for mounting panels, in particular photovoltaic panels or the like, on a roof, the method comprising the steps of:-

fixing a first panel support element to a roof, said first panel support element having engagement means for linking in predetermined juxtaposition with adjacent like panel support elements, each panel support element being adapted to releasably receive and support a photovoltaic panel or the like;

locating a second panel support element adjacent the first element and fixing the second element in a predetermined juxtaposition with the first element by the engagement means; and

attaching a solar panel or the like to each panel support element, the arrangement being such that the attached photovoltaic panels or the like are disposed in predefined juxtaposition.

The method of the present invention allows a substantially co-planar array of photovoltaic panels to be provided on a roof largely independently of the evenness of the roof. The underlying support structure, despite being modular can, when assembled, provide a substantially rigid structure to support the substantially co-planar array of photovoltaic panels.

In one particular embodiment of the method, when a framework is being applied to a tiled roof, the method further includes the steps of:-

removing a tile from the roof;

attaching a depending fastener to a rafter, or other structural member of the roof;

replacing the tile on the roof such that the upper end of the fastener is covered but leaving the lower part of the fastener exposed; and

attaching the panel support element to the lower part of the fastener.

In the case of roofs made of sheet material, such as roofs made of corrugated metal, fasteners may also be attached to a rafter, purlin or the like through the sheet material.

Each panel may be electrically connected in series to its adjacent panels by a length of cable which may be plugged directly into an inverter on the rear of the photovoltaic panel.

The invention also provides a panel support element having engagement means being adapted for linking with an adjacent like panel support element, each frame element being adapted releasably to support a photovoltaic panel, the engagement means being configured for securing adjacent panel supports such that their respective solar panels or the like are disposed in predefined juxtaposition.

In a preferred embodiment, the panel support element comprises a first elongate member having a length 2L and two transversely oriented elongate members each having a length L symmetrically disposed midway between the centre and either end of the first elongate member. Preferably hinge means are provided at each end of the transverse elongate members which are configured to co-operate with a hinge bracket provided on the reverse side of the photovoltaic panel.

Typically, the cross-section of the members of the panel support elements will be an inverted top hat shape.

Each fastener for attaching the panel support element to the roof preferably includes an elongate metal strap, optionally provided with preformed holes to facilitate attachment to the roof and the support element. An attachment clip is preferably also provided, which cooperates with the cross-section shape of the members of the panel support element, to clip onto the support element. The attachment clip is preferably provided with a plurality of holes to allow adjustable connection of the fastener strap by way of a screw or rivet. Preferably the holes in the attachment clip differ in pitch with respect to the fastener strap to allow a vernier style fine adjustment of the location of the support element. The attachment clip is preferably slidingly attached to the respective member of the support element to provide adjustment of the location of the support element in the direction of the respective member.

Preferably, the engagement means comprise bracket elements of a predetermined length defining mating means adapted to engage with corresponding mating means provided at a predetermined location at or adjacent each end of the members of the panel support element.

The corresponding mating means may include a pair of detents provided adjacent each end of the first elongate member and the two transverse elongate members.

Both the panel support elements and the photovoltaic panels have a length which is twice their width. This makes the design very flexible in providing an array of panels for roof faces of differing shapes. For example if an array of panels is to be fitted to a (triangular) gable end, the panels can be arranged in a landscape format (ie with the 2L side horizontally oriented) and with one panel disposed above two panels, those two panels above three panels, those three panels above four panels etc. Alternatively, the panels

can be assembled to provide a substantially rectangular array with the panels in either a landscape or portrait format.

After the frame work of panel support elements has been placed on a roof, it may be pre-wired leaving connectors located on each frame element for plugging into the photovoltaic panel subsequently placed on that element.

The system can be provided in modular kit form with all the parts necessary for assembling and fitting a photovoltaic panel to a roof, including:-

a fastener strap and attachment clip

a panel support element;

three connector bracket elements;

four hinge brackets arranged to be affixed to the rear side of a photovoltaic panel; and

connector cable of sufficient length to reach an adjacent juxtaposed panel or junction box.

Preferably the kit also includes photovoltaic panel and optionally an invertor arranged to convert a dc power output of the photovoltaic panel to ac power for connection to an ac power grid or a grid connected building distribution system.

The above can be provided in a single box. If the array is to have, say, six panels, six such boxes are required. A single separate box contains all of the components required to add a single panel to an array the kit component list being independent of the number of panels in the array.

Thus the present invention provides a single system and method which enables a framework of any required shape and size, to be accurately located on a flat or pitched, tiled or non-tiled, roof, which enables accurate and secure location of the photovoltaic panels.

Throughout this specification, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Brief Description of the Drawings

Specific embodiments of the invention will now be described, by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a panel support element;

Figure 2 is a perspective view of a hinge bracket;

Figure 3 is a perspective view of an attachment clip;

Figure 4 is a perspective view of a connector bracket;

Figure 5 is a perspective view of a fastener strap;

Figure 6 shows a typical tiled roof with an array of panel support elements attached to the roof.

Figure 7 is a cross-section on line VII-VII of Figure 6;

Figure 8 shows wiring laid out over the panel support elements and a solar photovoltaic panel being lowered onto a panel support element;

Figure 9 is cross-section through Figure 8; and

Figure 10 illustrates a roof after panels have been positioned on all the panel support elements provided on the roof.

Detailed Description of the a Preferred Embodiment

Referring to the drawings, Figure 1 illustrates a panel support element of the present invention, generally indicated at 10. The panel support element 10 comprises a first elongate frame member 12 and two transverse frame members 14, 16 which are symmetrically disposed about the centre and central longitudinal axis of the elongate member 12 The panel support element has a length (2L) which is approximately twice its width (L). The transverse frame members are spaced a distance L apart.

In cross-section the frame members 12, 14, 16 have an inverted top hat shape defining flanges 20 extending generally parallel to the plane of the panel support element.

Near each end of each elongate frame element a pair of V shaped detents 24 is defined in the flanges 20, as illustrated.

An upstanding hooked projection or hinge 26 is defined at each end of each transverse frame element.

Figure 2 shows a hinge bracket 40 made from stainless steel. The bracket comprises a generally planar portion 41 along the sides of which extend two triangular wings 42, 44 in a plane generally perpendicular to the planar portion 41. Extending away from the planar portion 41, in a plane

perpendicular to both the wings and the planar portion, is a shaped sheet including a first portion 46 which extends perpendicularly away from the planar portion 41, a step portion 48 perpendicular to portion 46 and a further planar portion 50 which extends at an angle of about 30° to the planar portion 46. In use four such brackets are fixed to the reverse side of a photovoltaic panel 120, towards the corners of two opposed edges of the panel (referred to herein as quarter points), as is best seen in Figure 8, with the portion 41 fixed by adhesive tape or the like to the reverse side of the panel 120.

Figure 3 shows an attachment clip 60 which is generally U-shaped in section and has two pairs of slots 66 defined in its sides 68, which are shaped to snap-fasten over flanges 20 of the panel support element 10. The base 62 defines a series of holes 64 , for connection of the support element to a mounting mechanism.

Figure 4 illustrates a connector bracket 70 which is generally U shaped having a base 72 in which there are two spaced transverse slots 74. At each side of each end of the connector there is a triangular projection 78 which, as is explained in more detail below, slots into detents 24 in flange 20 of the panel support element 10.

Figure 5 illustrates a fastener strap 80 comprising elongate strip of planar metal provided with a series of holes 82 spaced along its central longitudinal axis. The holes 82 are provided, on the one hand, for attachment of the strap to a roof component such as a rafter, and on the other hand, for attachment of the strap to the attachment clip 60. The holes 82 in the strap 80 are spaced at a different pitch to that of the holes 64 in the attachment clip 60, such that a vernier adjustment is provided between the strap 80 and the clip 60. In the illustrated embodiment the clip 60 has nine equally spaced holes 64 and over the same total length the strap 80 has ten holes. Attachment of the strap 80 to the roof is by way of suitable screws, nails or rivets and attachment of the strap to the clip 60 is by way of nut and bolt, self tapping screw, rivet, or suitable similar fastener.

Figures 6 onwards illustrate the use of the frame elements and other components of the present invention to install an array of solar panels on a roof. The roof includes a series of rafters supporting tiles 114.

Figure 6 illustrates a method of fixing frame elements to a tiled roof 112. First a number of tiles 114a are removed from the roof to reveal the

supporting rafters of the roof. Next, fastener straps 80 are fixed to the rafters, using screws, nails or the like, one end being fixed to rafter and the other end depending down the roof parallel to the rafter. When the tiles 114a are replaced as shown in Figure 6, the lower ends of the fastener straps 80 are visible. In Figure 6, two fastener straps are shown bent upwards, this is for illustrative purposes only, to show attachment brackets 60 more clearly.

A first panel support element 10a is then positioned on the roof with a attachment clip 60 attached as shown in Figure 7 and the attachment clip is fixed to the fastener strap 80, by a pop rivet 126 which passes through one of the holes 82 in the fastener strap 80 and a suitably aligned hole 64 in the attachment clip 60. At this stage the panel support element 10a may move laterally along the roof relative to the strap 80 and attachment clip 60.

A second panel support element 10b is juxtaposed a set distance from the first panel support element 10a which has already positioned on the roof the distance between the two panel support elements 10a, 10b being set by means of a connector bracket 70 which connects them. The projections 78 at the ends of the connector brackets snap into the detents 24 on the members of the panel support elements and hence hold the elements in a pre-determined position relative to each other.

Further panel support elements are then fixed to the roof using further connector brackets, until a row of linked panel support elements is formed. Fastener straps 80 are used as required to assist in locating and supporting the panel support elements 10 although it is not necessary to have a fastener strap for each panel support element as the panel support elements are supported by the adjacent juxtaposed panel support elements in the array, particularly when several row of support elements are used. Large assemblies of panel support elements can be supported by as few as three or four fastener straps.

Once a complete row of panel support element is located on a roof, a further row of panel support elements can be added to the roof connected to the first row using the connector brackets 70. The slots 74 in the brackets 70 allow the projections 26 on the panel support elements to pass through the brackets. The number of rows which can be provided is limited only by the size of the roof. In Figure 6 two rows are shown only.

Figure 7 shows a vertical cross-section through a panel support element 10, an attachment clip 60 and a fastener strap 80, showing the

relationship between the panel support element 10, the fastener strap 80 and attachment clip 60, which hold the support element 10 to the roof, and the roof batten 127, to which the fastener strap 80 is fastened by a nail or screw 128, and the roof tiles 114, 114a.

As shown in Figure 8, after the panel support elements 10 are located and fastened to the roof, connector wires 116 are laid out on the array of panel support elements. The wires 116 pass under the connector brackets 70 as this part of the wire is not located below the photovoltaic panel which is to be supported by the panel support element and thus would otherwise be exposed to ultraviolet radiation. Both ends of the wire are terminated by connector elements 118 for plugging into an inverter 119 on the rear of a photovoltaic panel 120. The wiring extends from panel support element to panel support element and only a single pair of wires extend into the roof space. The panels in the array will generally be connected in parallel, but may also be connected in series, as for example in some dc installations.

Figure 8 also illustrates a solar panel 120 in the process of being lowered onto it's respective support element 10. As can be seen, the rear side of the panel 120 is fitted with four hinge brackets 40 located at the quarter points of the panel and fixed to the panel by double sided tape (not shown). The hinge brackets 40 engage with the upstanding projections 26 of the panel support element. The upstanding projections 26 of the panel support element 10 and brackets 40, co-operate to act as hinges and allow the panel 120 to be lowered onto the panel support element with the load carried by the uppermost tips of a pair of the projections 26 during the lowering operation and the tips of all four projections 26 once the panel is in it's final position. An inverter is also located on the underside of the photovoltaic panel. The connector terminations 118 of the wiring 116 are pushed into mating connectors (not shown) in the inverter on the photovoltaic panel and the panel is lowered until the free brackets 40 engage their respective projection 26. Figure 9 shows a vertical cross-section through the panel 120 and support element 10 assembly, and illustrates the panel 120 engaged in place on the panel support element 10. The remaining panels 120 are fixed on the support elements 10 in a similar manner. Figure 10 illustrates a completed roof in which a small assembly of six panels have been installed.

For corrugated iron roofs or similar roofs, the support frame may be fixed with the fastener straps 80 as described above, or may be screwed directly to the roof.

The top hat section of the members 12, 14, 16 of the panel support elements 10 provides strength to the structure and assists in preventing the panel support elements from flexing.

The panels 120 are raised off the roof to allow free air flow to the back of the panels and avoid the obstruction of rain water flowing down the roof into the gutter.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

Dated this thirty-first day of August 1998

PACIFIC SOLAR PTY LIMITED
Patent Attorneys for the Applicant:

F B RICE & CO

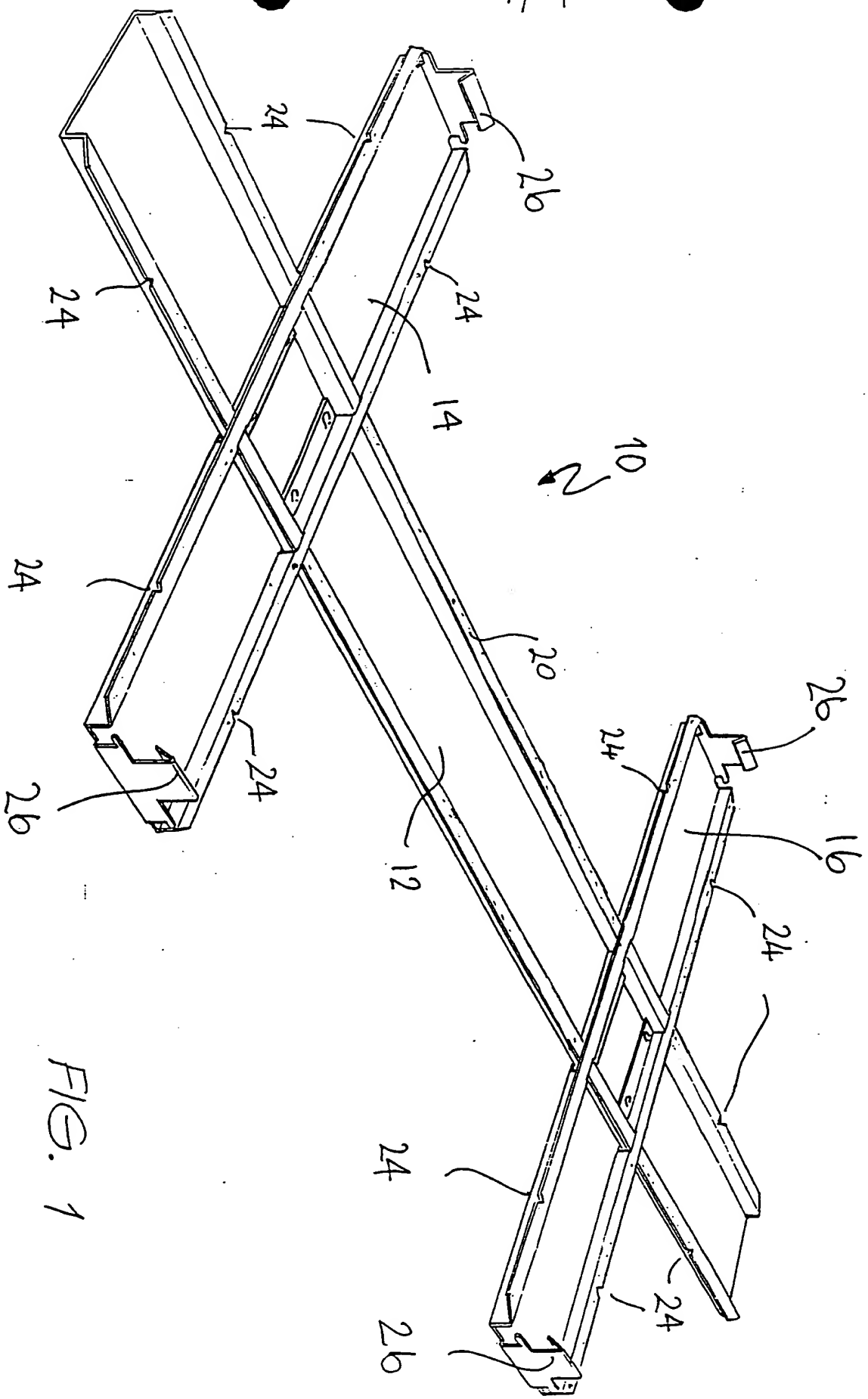

FIG. 1

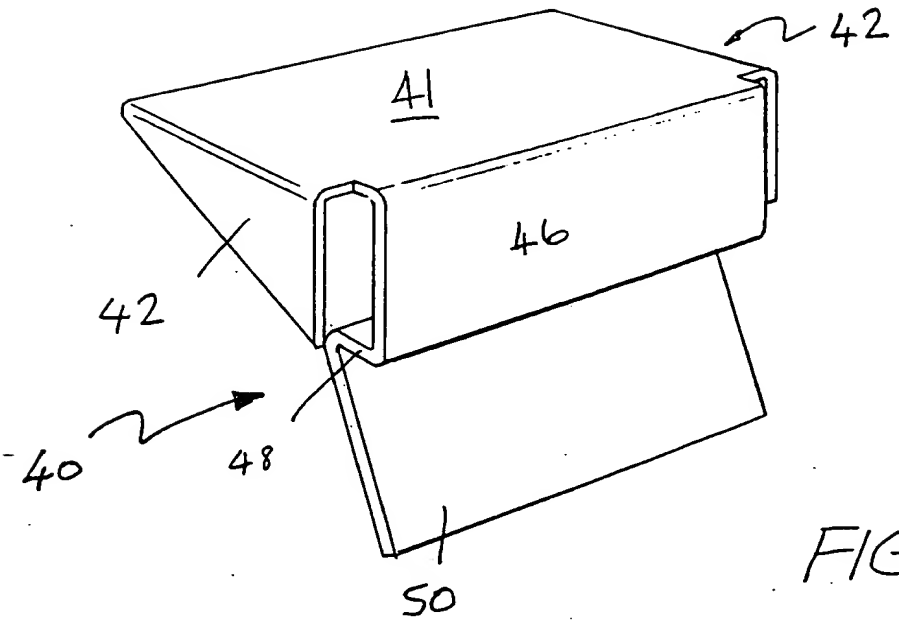

FIG. 2

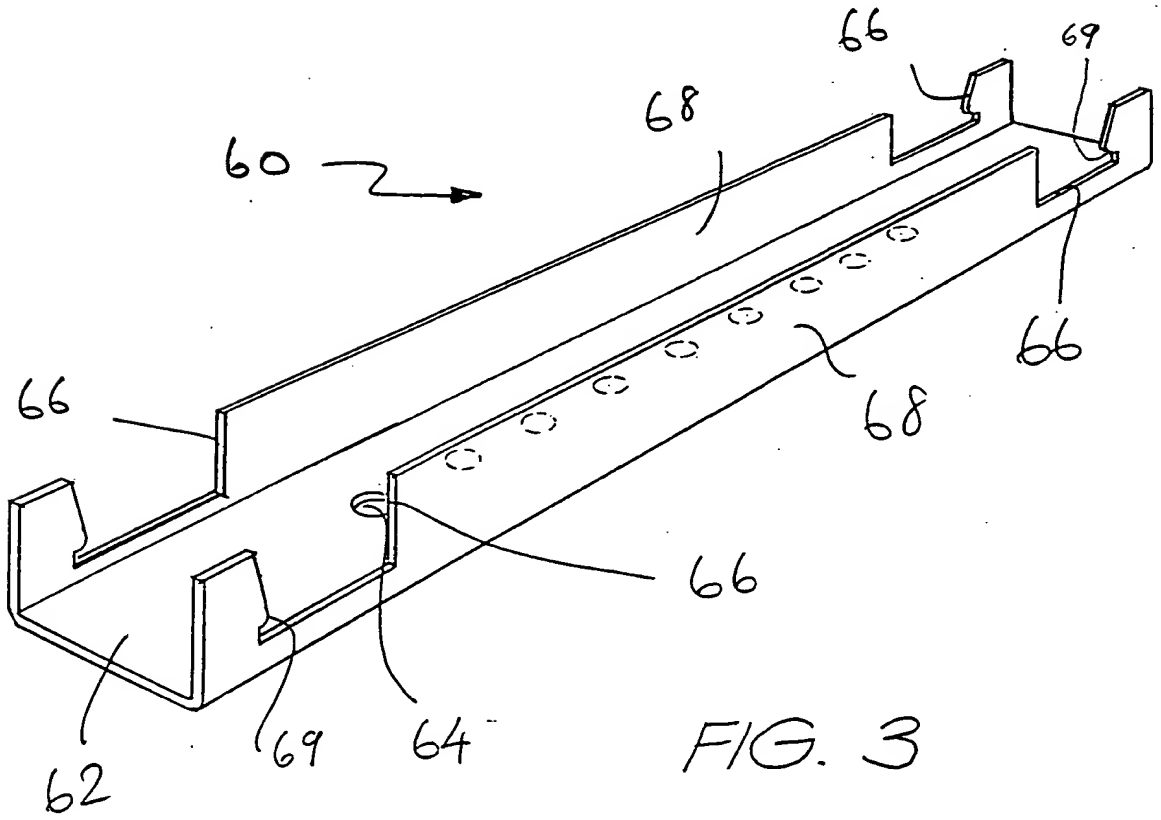

FIG. 3

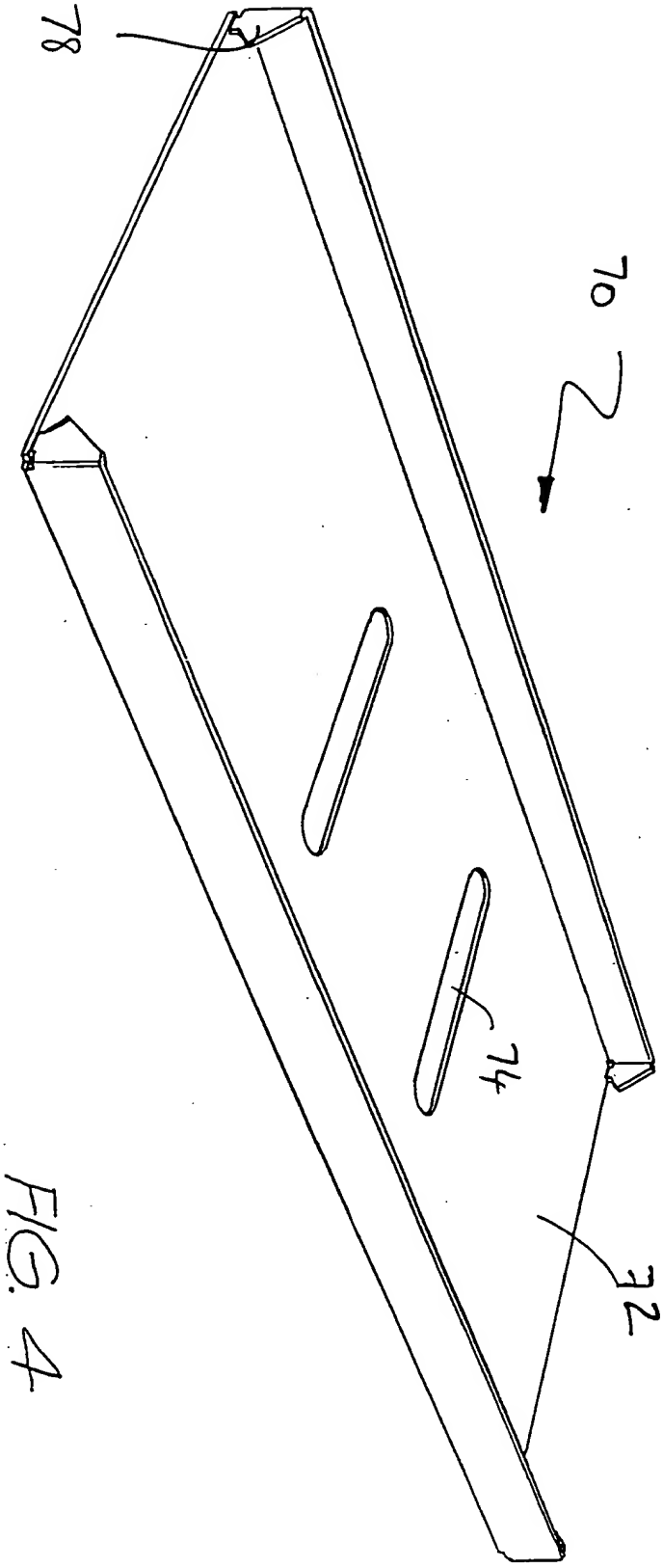

FIG. 4

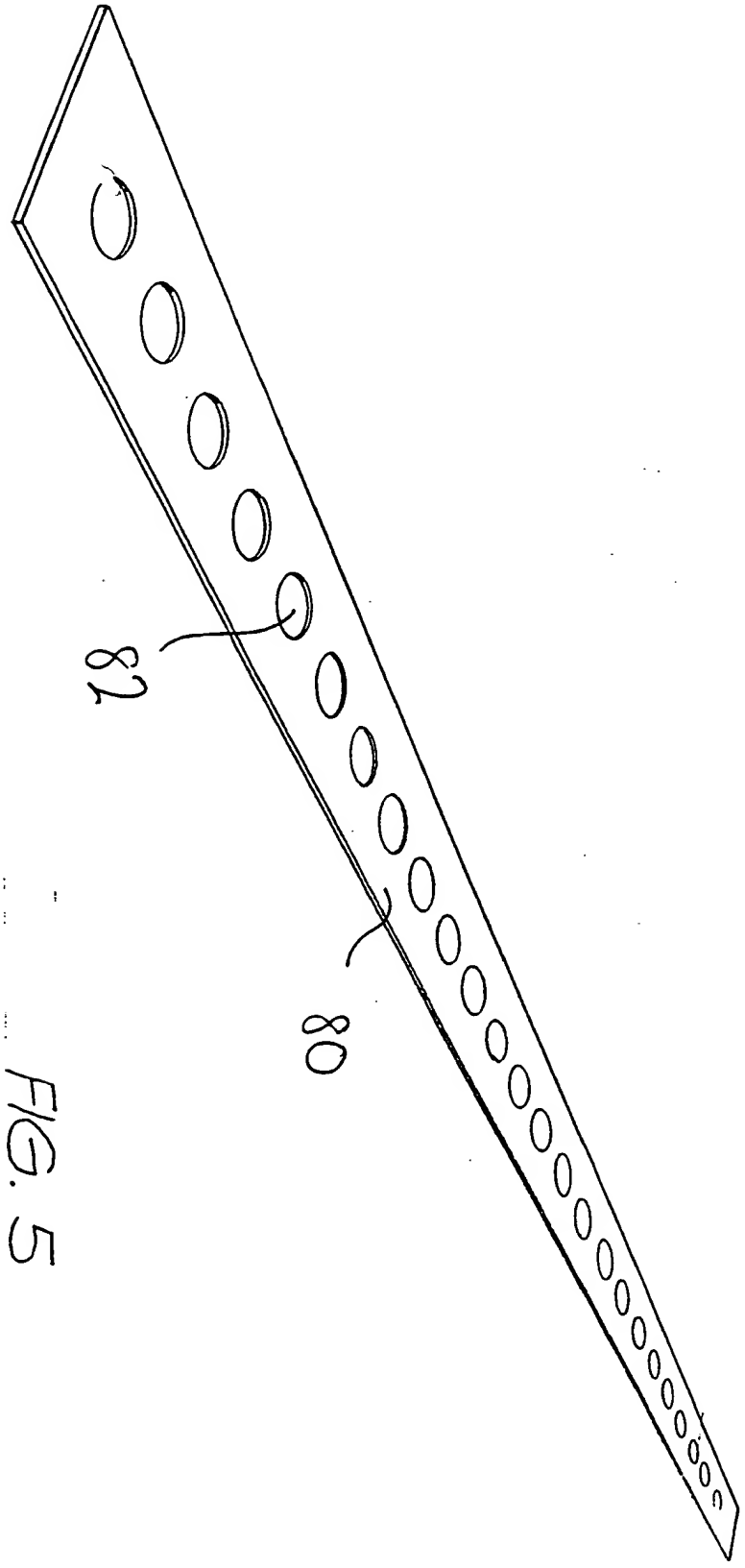

FIG. 5

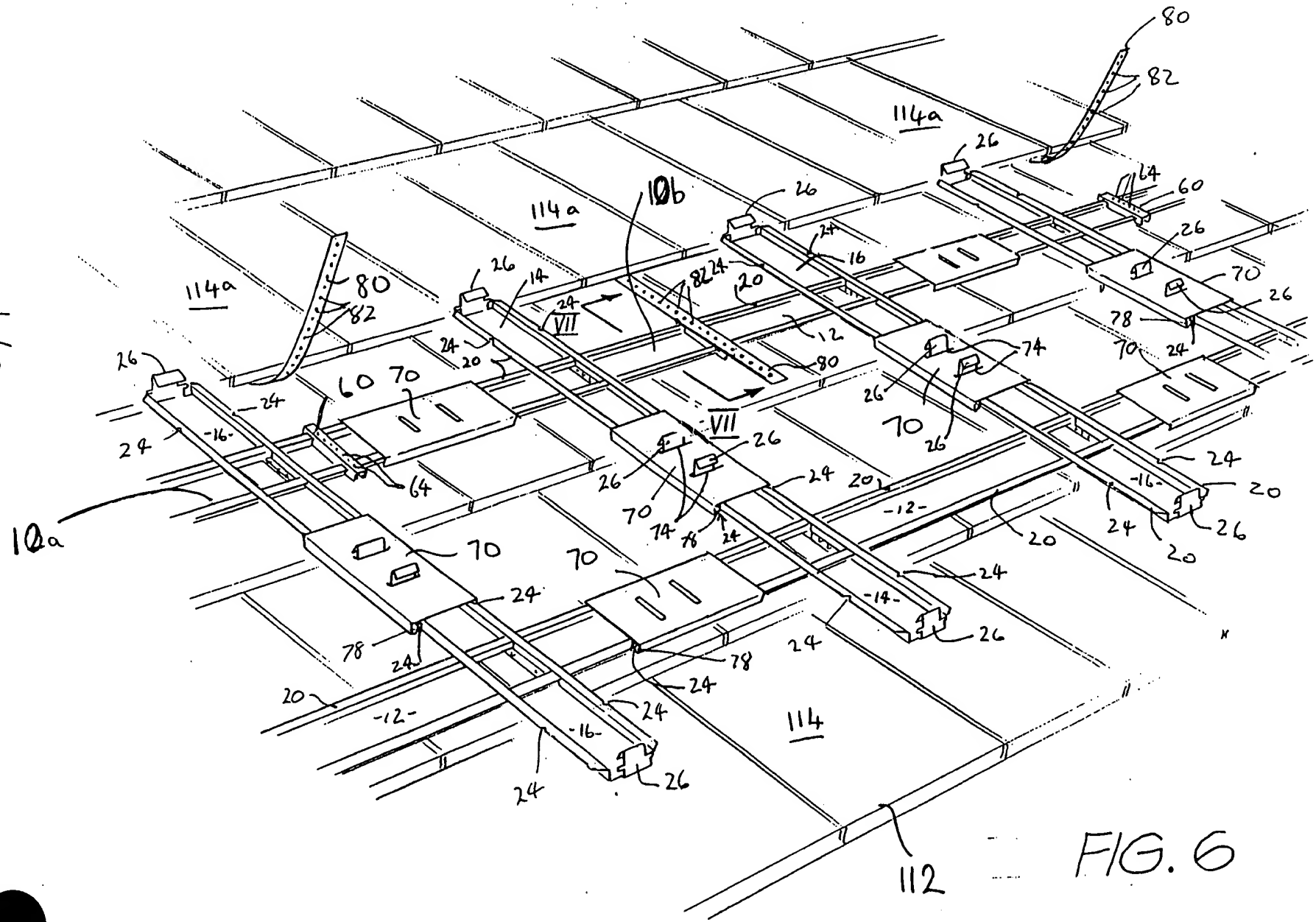
80
82
114a
26
64
60
70
78
74
24
16
20
12
14
VII
10b
10a
-16-
-12-
-14-
114
112

FIG. 6

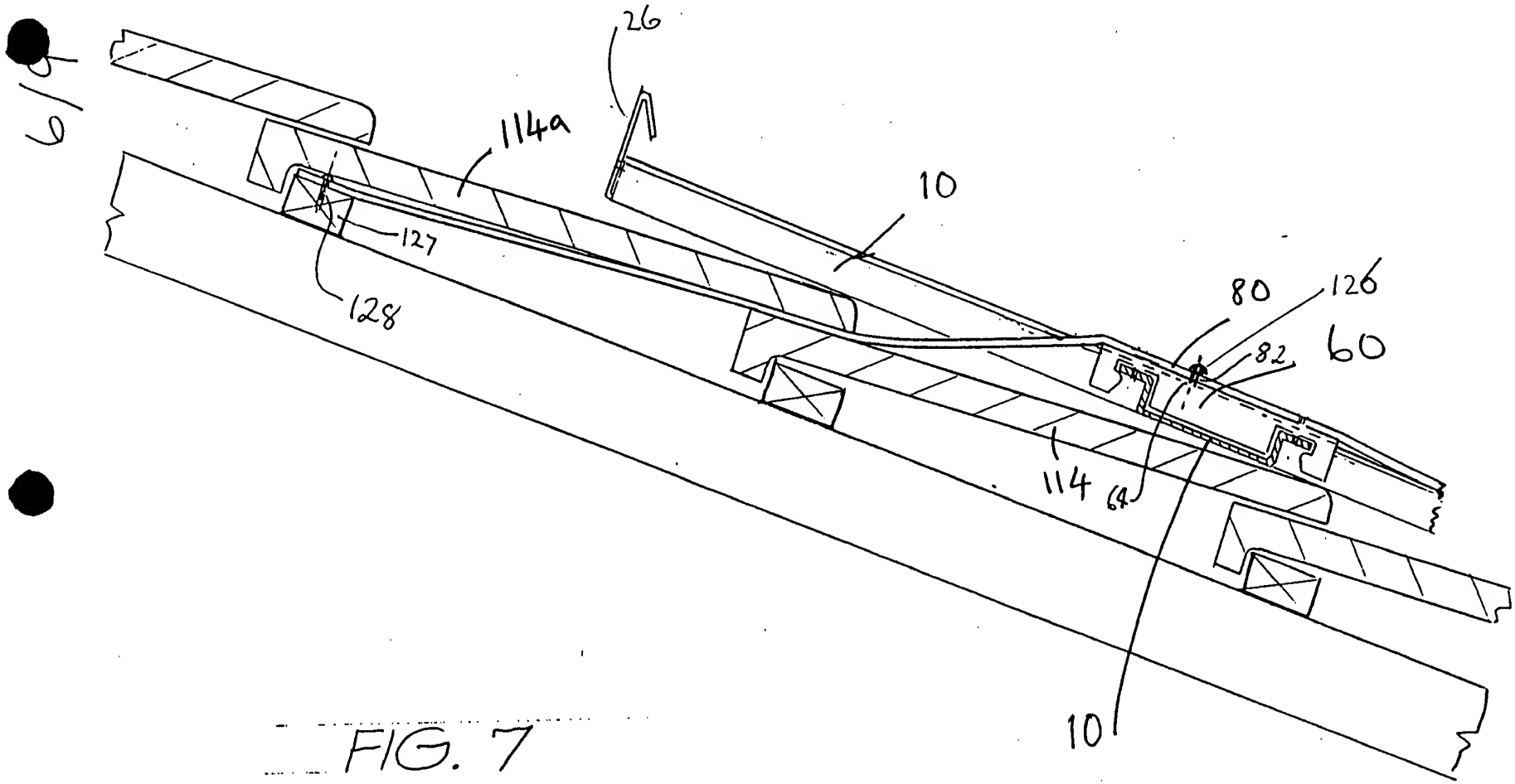

FIG. 7

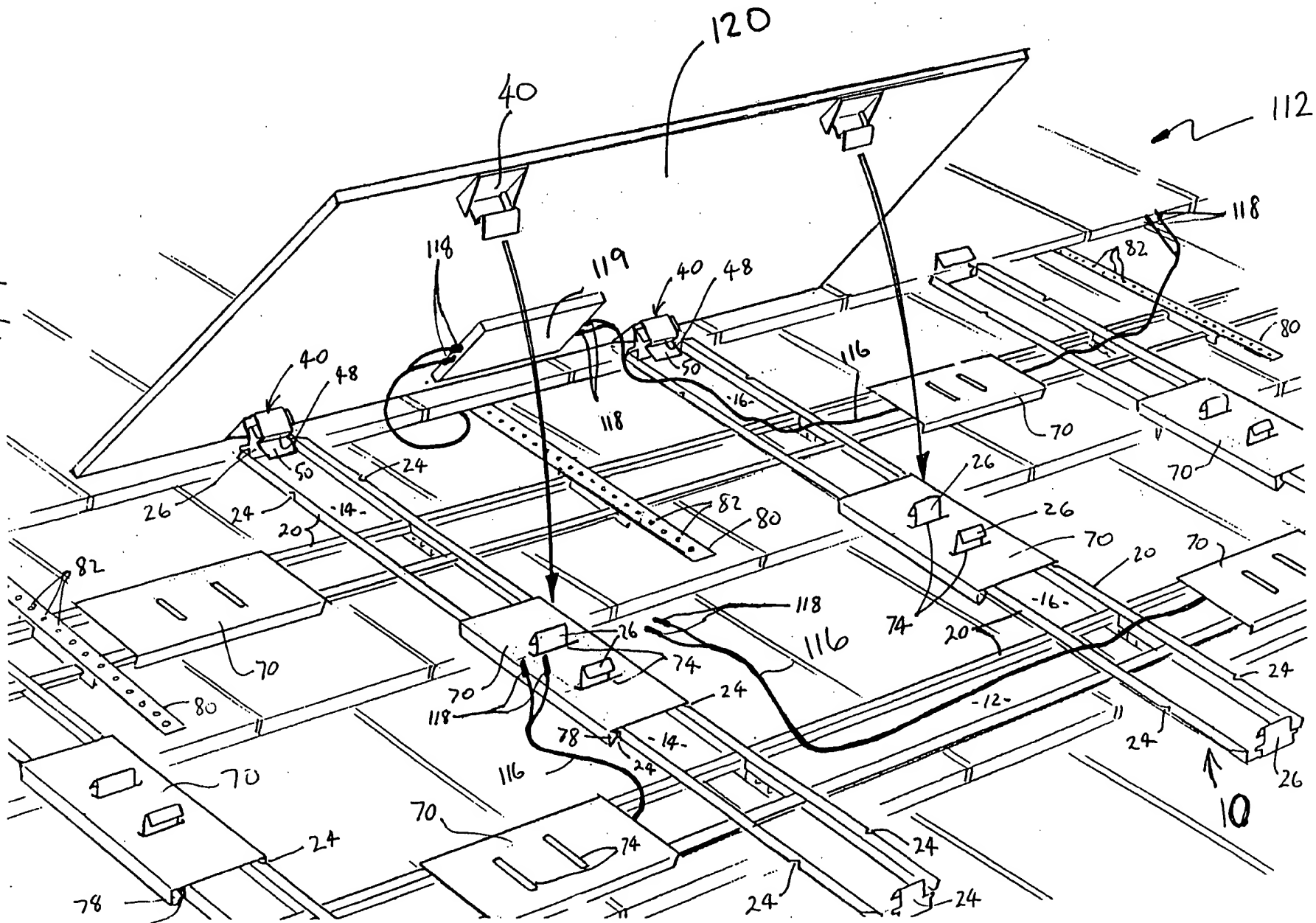

FIG. 8

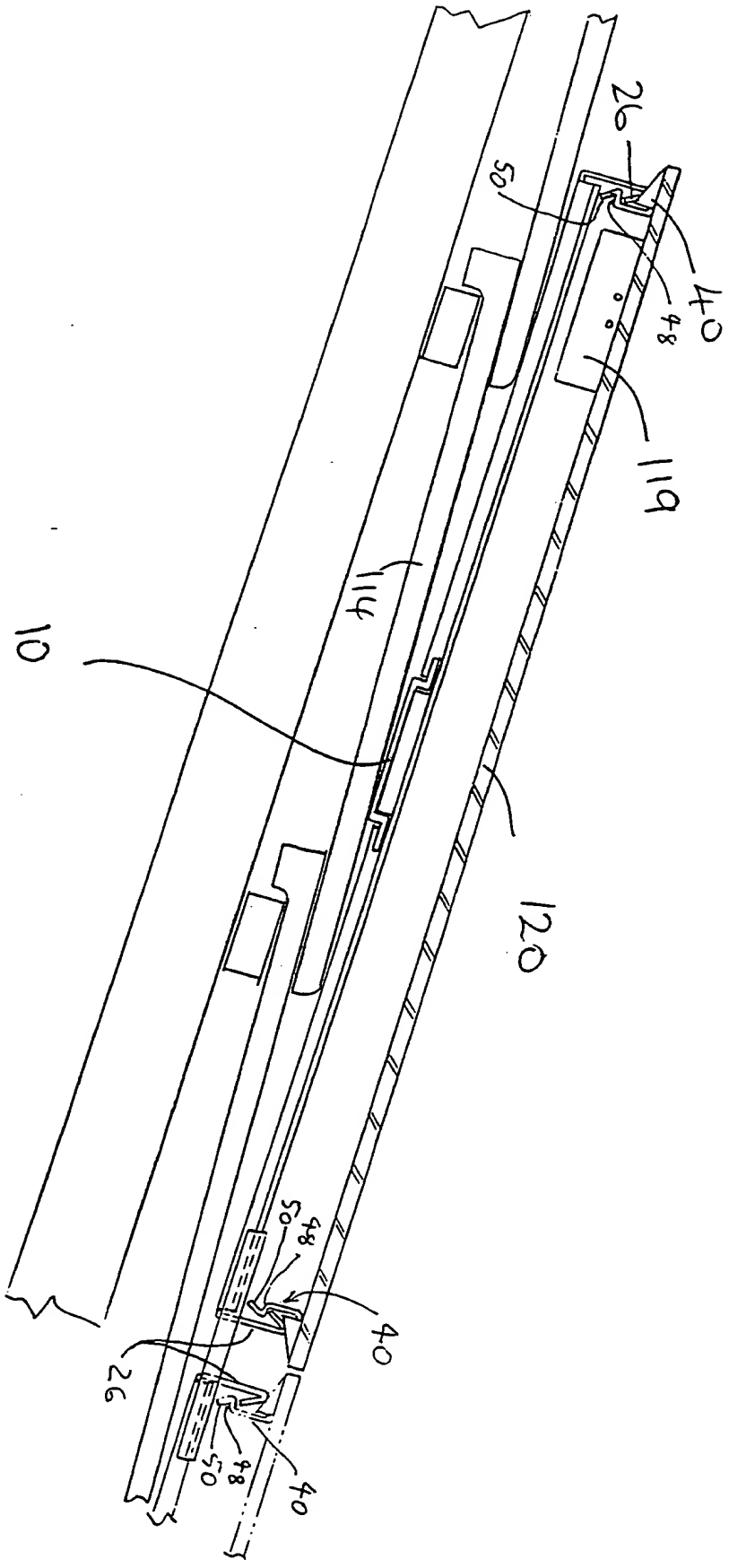

FIG. 9

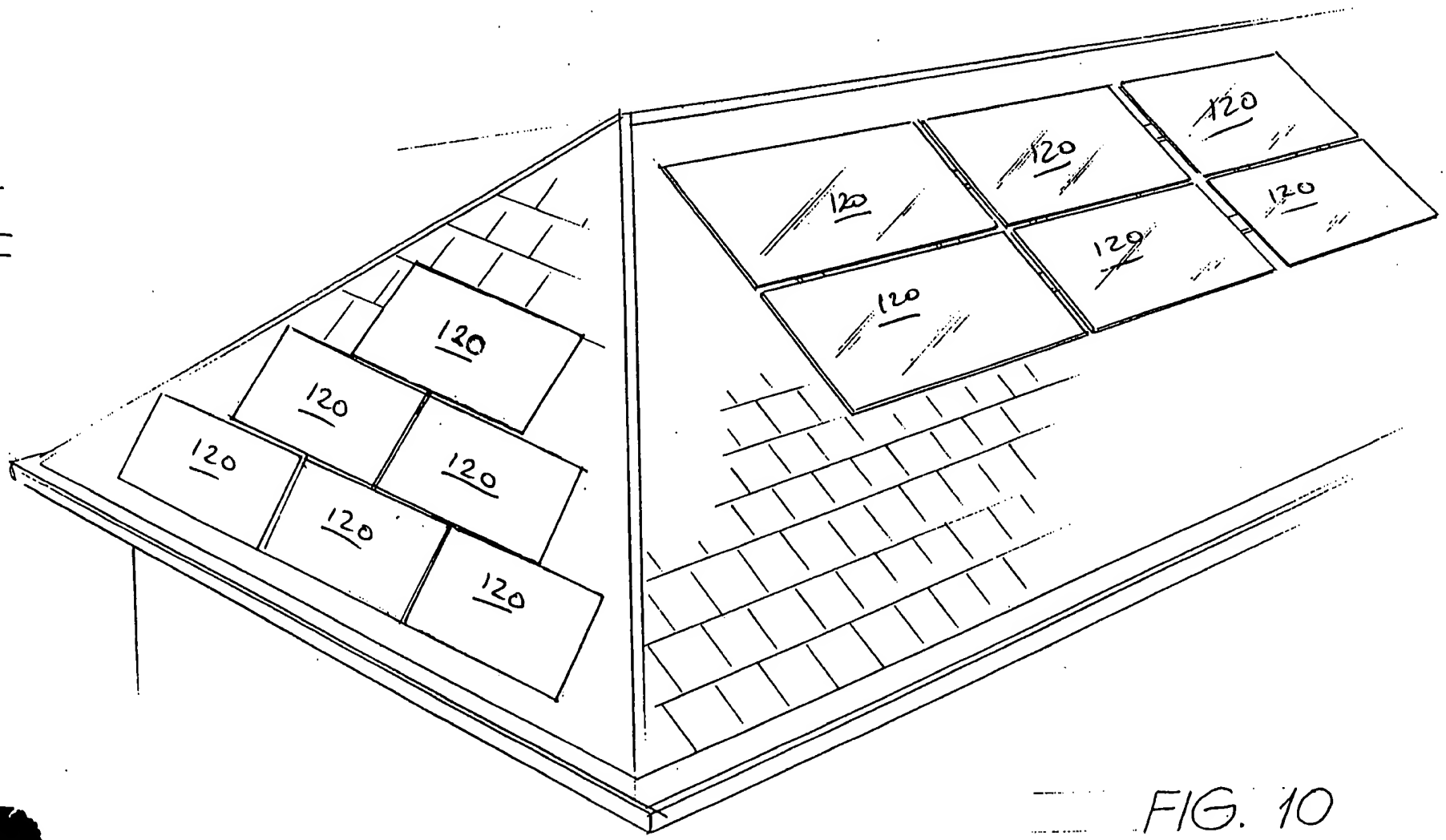

FIG. 10